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DEVELOPMENT of the CHIPPING HEADRIG

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Peter Koch

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DEVELOPMENT OF THE CHIPPING HEADRIG[1/]

Peter Koch
Southern Forest Experiment Station
Forest Service, U. S. Department of Agriculture
Alexandria, Louisiana

It is a pleasure to have the opportunity to discuss the history and possibilities of chipping headrigs with mill men from Colorado and neighboring States. The equipment should be of interest to you, because 40 percent of the timber of the region is in diameter classes optimum for conversion by such headrigs, i.e., 5 to 10.9 inches d.b.h.

I was specifically asked to talk about the research leading to the manufacture of the chipping headrig. The development is by no means complete, and my assignment is accordingly made more difficult. The history as I describe it is colored by my own participation in the events. It is probable that another observer would have a different idea of the course of development.

BASIC RESEARCH

In 1949 Eero Kivimaa, a Finn working in Helsinki, performed a series of well-organized experiments that revealed some of the fundamentals of chip formation and cutting forces.

In the years immediately following World War II, I was engaged in designing and manufacturing heavy-duty, high-speed planers and matchers with Stetson-Ross Machine Company in Seattle. In 1953-54 I undertook a year of privately financed research to study the effect of chip formation on cutterhead horsepower and quality of surface generated in peripheral milling.

In 1956-57 Norman C. Franz, at the University of Michigan in Ann Arbor, executed a series of experiments on chip formation and forces in orthogonal cutting. Orthogonal cutting is most easily visualized as the action of a carpenter's hand plane.

1/ Based on a paper read at Rocky Mountain Forest Industries Conference, Fort Collins, Colorado, April 1967.

Kivimaa's manuscript was published in English in 1950. My doctoral thesis was completed in 1954 and portions of it published in 1955-56. In 1958, Franz's work was published. This series of papers undoubtedly stimulated a good deal of additional research on chip formation.

My unpublished 1954 thesis contained nearly 100 carefully selected photographs of chips forming under the action of knives. The photographs were taken at an exposure of one-millionth of a second to stop the motion of the cutterheads, which turned at 3,600 r.p.m. The 8- and 12-knife heads were of a size commonly used in industry, as were the depths of cut and feed speeds. There were only six copies of this original thesis. I have two, the University of Washington has two, a cooperator (Tom Caskey) has one, and Stetson-Ross was given one. The photographs stimulated Stetson-Ross to manufacture, during the 1950's, auxiliary chipping machines for mounting on the bridgeplate at the infeed end of the company's heavy-duty planers (fig. 1). This auxiliary equipment consisted of top and side chip blanking heads that removed the excess width and thickness of rough green dimension lumber (in the form of pulp chips) before it entered the planer proper. The heads were of the segmental type, i.e., with stacked discs, and rotated with the feed to accomplish climb-milling. A number of the machines were sold, and their use considerably advanced the knowledge required to build chipping headrigs and edgers.

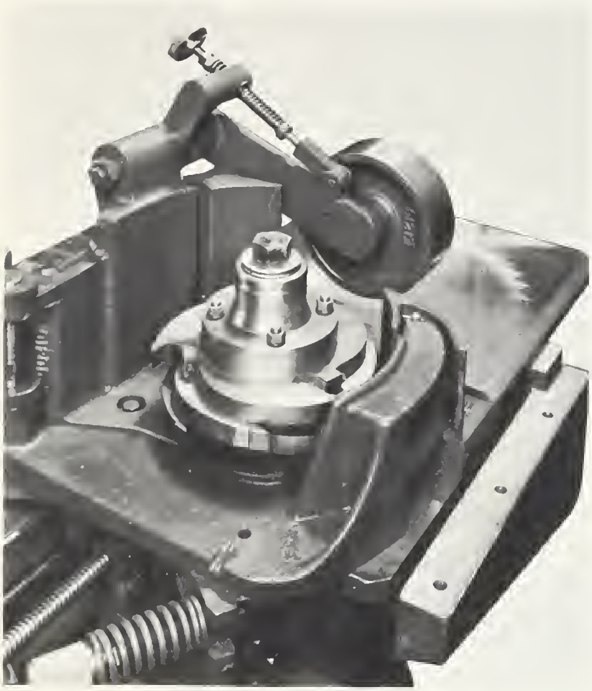


Figure 1.--Chip-blanking, climb-milling cutterhead on outer side-head of planer and matcher (Koch, 1964b, p. 304).

Any discussion of chipping headrigs must start with an explanation of chip formation during peripheral milling. While a detailed treatment of the kinematics, force systems, and chip severance phenomena is available (Koch, 1964b), a very brief account will suffice for present purposes.

Peripheral milling may be defined as the removal of excess wood in the form of single chips; the chips are formed by the intermittent engagement with the workpiece of knives carried on the periphery of a rotating cutterhead. The finished surface therefore consists of a series of individual knife traces generated by the successive engagement of each knife.

Figure 2 illustrates terminology for a peripheral-milling cutterhead. There are two possibilities of workpiece feed-direction in relation to the direction of cutterhead rotation. Chipping headrigs employ climb-milling--i.e., the engaged knives move in the same direction as the workpiece. In conventional planers, the engaged knives move counter to the movement of the workpiece--an action termed up-milling.

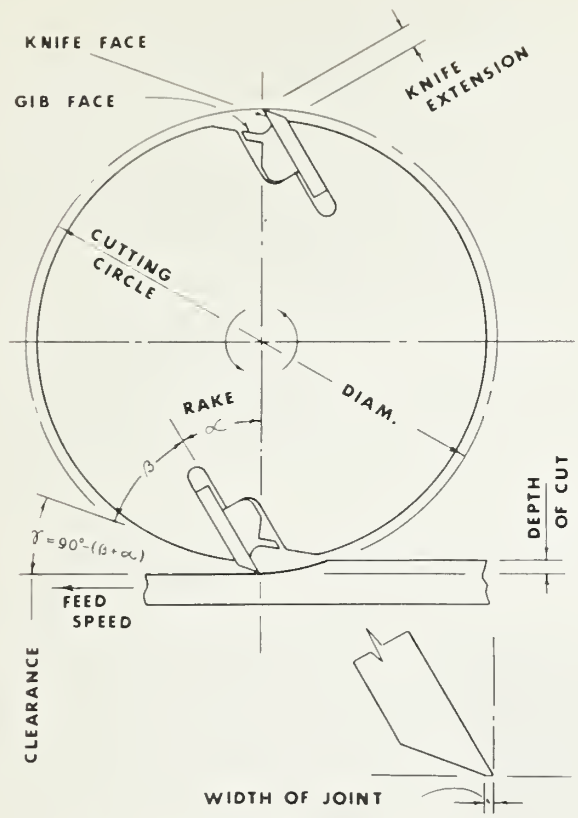


Figure 2.--Terminology for peripheral-milling cutterhead. Up-milling illustrated (Koch, 1964b).

The cycloidal path taken by each knife tip can be represented (fig. 3) by considering the workpiece fixed in space and allowing the cutterhead to rotate about a roll circle of a diameter that gives a relative translatory velocity equal to the desired feed speed. This concept can be visualized through employment of a rack and pinion, as shown in figures 4 and 5. Finally, the high-speed photographs of figure 6 illustrate the difference between climb- and up-milling. In climb-milling the knife enters the work at the rough surface and leaves at the finished surface; the chips are discharged parallel to the workpiece.

It has been demonstrated (Koch, 1954) that very capacious and carefully rounded gullets between knife face and gib face are required to minimize both chip fragmentation and cutterhead power; that chips should be cut from green wood; that rake angle must be high--approximately 40-45 degrees--to keep horsepower consumption low; and that the clearance angle should be $7\frac{1}{2}$-10 degrees.

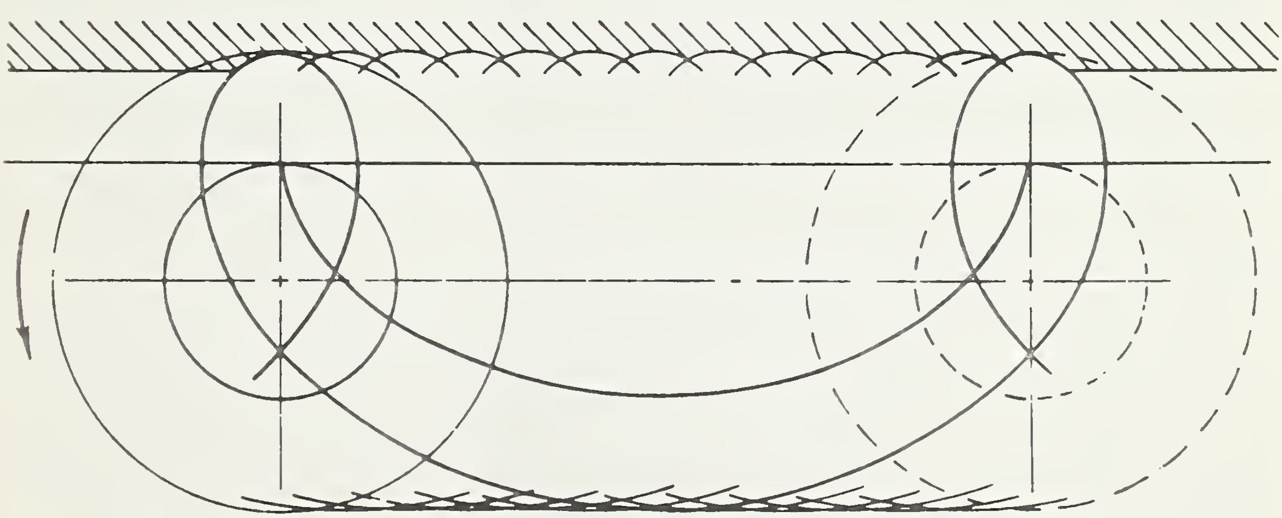


Figure 3.--Curtate trochoid. Upper surface generated by climb-milling, lower by up-milling (Koch, 1964b).

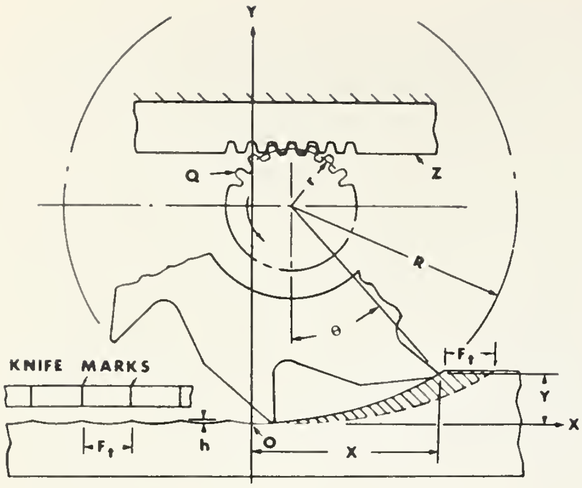


Figure 4.--Path generated by up-milling cutter knife (Koch, 1964b).

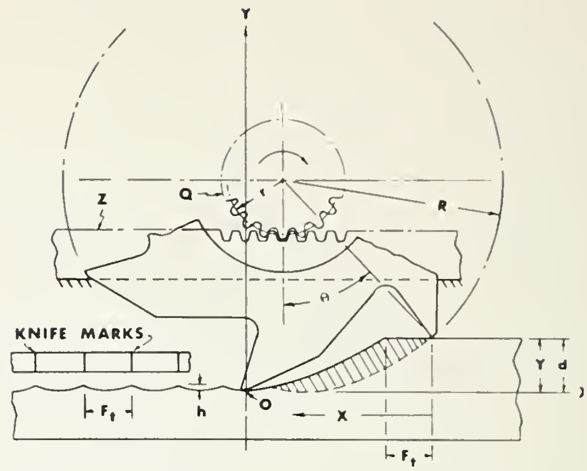


Figure 5.--Path generated by climb-milling cutter knife (Koch, 1964b).

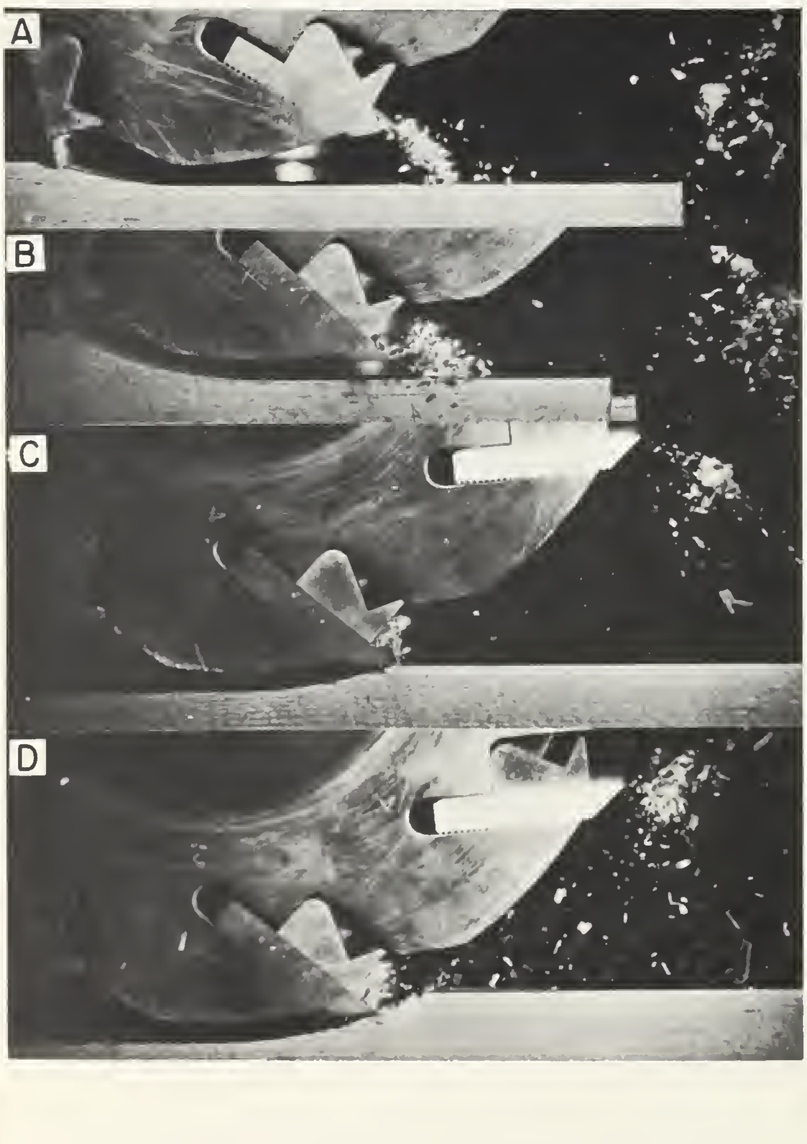
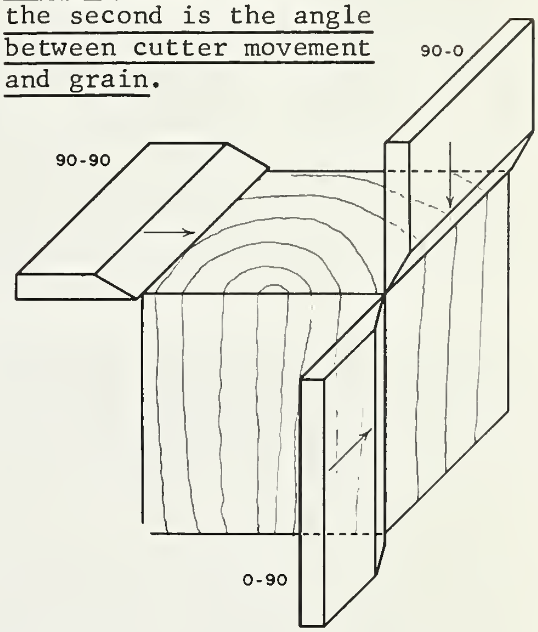


Figure 6.--Comparison of up-milling and climb-milling. Feed speed, 175 f.p.m.; 8-knife cutterhead; rake angle, 30 degrees; nominal r.p.m., 3,600. A.--Climb-milling, $\frac{1}{4}$-inch depth of cut; B.--Climb-milling, $\frac{1}{2}$-inch cut; C.--Up-milling, $\frac{1}{4}$-inch cut; D.--Up-milling, $\frac{1}{2}$-inch cut (Koch, 1954).

It has also been shown (Koch, 1954) that in peripheral milling specific cutting energy is minimized if chips are made as thick and long as possible, and that climb-cutting uses substantially more cutterhead power than does conventional up-milling. Because the climb-cutter tends to throw the workpiece out of the back of the machine--i.e., it tends to be self-feeding at an uncontrolled rate--the feedworks requires less horsepower and firmer control over the workpiece than with an up-milling cutter.

Figure 7 illustrates the three major cutting directions in wood. Kivimaa (1950) and others have shown that cutting energy is least in the 0-90 direction and most in the 90-90 direction. The 90-0 direction is intermediate. This fact has major implications.

Figure 7.--Designation of the three major machining directions. The first number is the angle the cutting edge makes with the grain; the second is the angle between cutter movement and grain.



APPLIED RESEARCH

Some years of independent research culminated in 1963 when I undertook (as a member of the U. S. Forest Service and with the cooperation of both Stetson-Ross and Mattison Machine Works) to construct three experimental models of chipping headrigs that cut in each of the modes (U. S. Forest Service, 1964). The three designs create chips or flakes by distinctly different cutting actions: (1) Cutting with a shaping-lathe configuration (fig. 8A) in which the knife edge is parallel to the grain but moves perpendicular to the grain, i.e., 0-90 mode. (2) Endmilling with chip severance accomplished by cutting across the grain with the knife edge at right angles to the grain, i.e., 90-90 mode. The saw illustrated in figure 8B proved unnecessary and was later removed. (3) Peripheral milling (fig. 8C) with the knife edge perpendicular to the grain but traveling more or less parallel to the grain. This approximates the 90-0 mode and approximates planing with a climb-cutter.

Machine designs were roughed out for the shaping-lathe and the planing configurations, and machine prices were estimated (Koch, 1964a). These headrigs were designed for logs of uniform short lengths and variable but small diameters. The designs contemplate gripping the logs between lathe centers while the machining is performed. Each headrig is capable of cutting, in a single 12-second operation, an accurately sized, heart-center S4S cant plus pulpable chips (or flakes for flakeboard). Neither sawdust nor slabs are produced.

Specific cutting energy for 3/4-inch-long pulp chips cut from green slash pine averaged 0.011 horsepower-minute per cubic inch of wood removed for the end-milling configuration (fig. 8B), but only 0.0023 hp.-min. for the planing configuration (fig. 8C). Flakeboard flakes cut 1 inch long and 0.015 inch thick

Figure 8.--Three configurations of chipping headrigs and resulting chips. The saw in the end-milling configuration (B) proved unnecessary and was later removed (U.S. Forest Service, 1964, p. 60).

were made at an expenditure of 0.009 hp.-min. per cubic inch of wood removed with the shaping-lathe configuration (fig. 8A). It is evident that heads can be mounted to cut at intermediate angles with energy requirements intermediate to the extremes illustrated.

COMMERCIAL MACHINES

While these three designs have the advantage of accurately locating the workpiece in space (by means of lathe centers), they lack the flexibility required for handling random-length logs.

The experimentation on the end-milling and planing configurations was done in the Stetson-Ross shops during the summer of 1963; that on the shaping-lathe configuration was done at the Mattison Machine Works, Rockford, Illinois, in early summer of the same year. Stetson-Ross's participation influenced it to acquire manufacturing rights to a chipping headrig that Lionel Pease had been independently developing in Seattle during the late 1950's and early 1960's. Pease's machine operates on the planing principle (fig. 8C) and can handle random-length logs. This design, considerably reworked, is now on the market as the Stetson-Ross "Beaver." A chipper-edger (the "Chipmunk") employing the planing principle is also manufactured by Stetson-Ross.

In 1962 Ernest E. Runnion of Shelton, Washington, applied for a patent on another chipping headrig--the "Chip-N-Saw"--operating on the planing principle (fig. 8C). This machine, which is capable of milling profiled patterns on random-length logs, is now manufactured by Canadian Car (Pacific) Division, Hawker-Siddley Canada, Ltd. Canadian Car also manufactures a chipper-edger that operates on the planing principle.

Two less well known machines for random-length logs have been marketed. Both employ modified end-milling configurations (fig. 8B). These and the two planing machines are described in the following pages. No commercial machines have yet been introduced to exploit the shaping-lathe idea (fig. 8A).

Stetson-Ross Beaver

The Beaver (fig. 9) is a 4-head planing machine with segmented cutterheads made of stacked discs (fig. 10). Two models are manufactured--the No. 4 can handle logs up to 24 inches in diameter, and the No. 2 is for logs 14 inches and smaller. The first installation was made at a Montana sawmill in 1963 to cut 2 by 4's from lodgepole pine. Considerable difficulties were experienced with a few of the earliest machines, but the more recent units (as manufactured by Stetson-Ross) are reported to give excellent performance.

The feedworks is distinctive (fig. 11) because it centers the log vertically and laterally to yield a pith-center cant. A top-loader is provided to speed entry of each log into the feedworks, which characteristically runs at 183 f.p.m. lineal feed speed to permit cutting 5/8-inch chips.

Purchasers of early models of the machine did not fully appreciate the productiveness of the equipment and failed to design infeed machinery capable of supplying logs at the required rate.

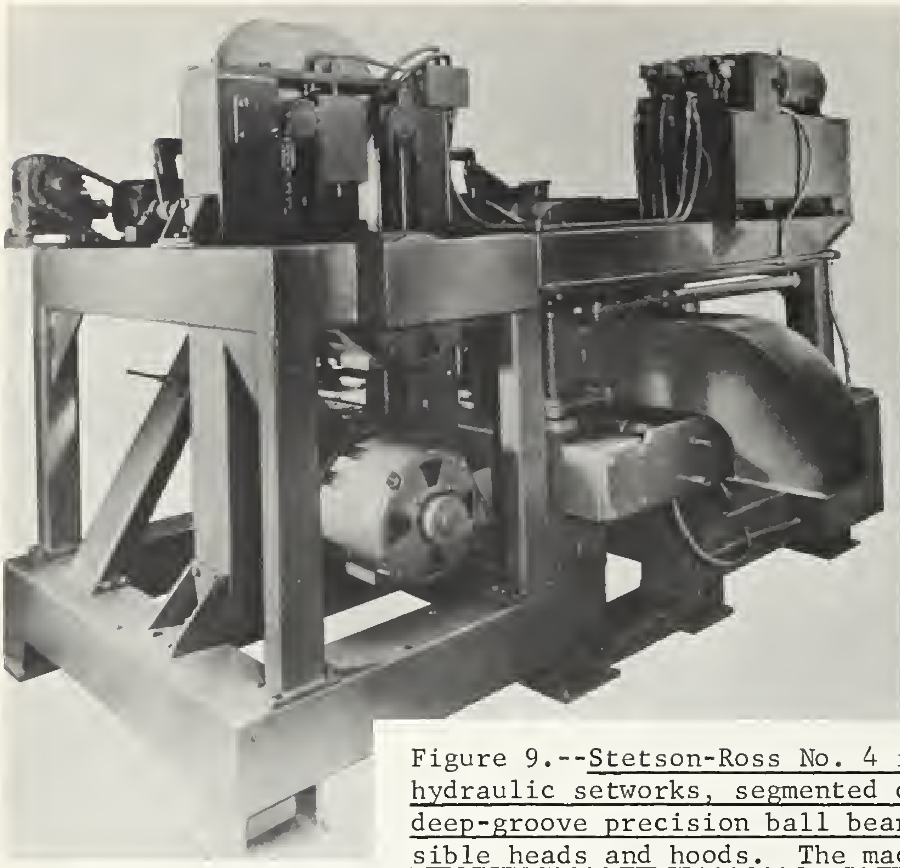


Figure 9.--Stetson-Ross No. 4 four-head Beaver with hydraulic setworks, segmented cutterheads carried in deep-groove precision ball bearings, and easily accessible heads and hoods. The machine will accept logs up to 24 inches in diameter. Nominal feed speed is 183 f.p.m. (Stetson-Ross photo).

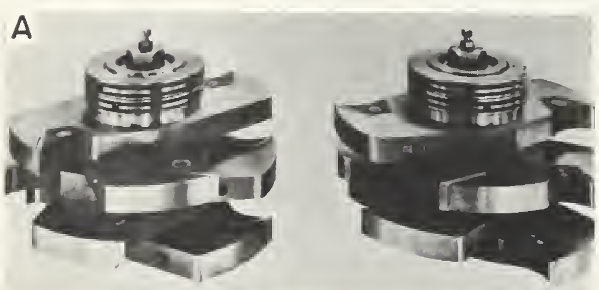


Figure 10.--A.--Assembled cutterheads of the Beaver. B.--Method of holding chipping knives in the heads (Stetson-Ross photo).

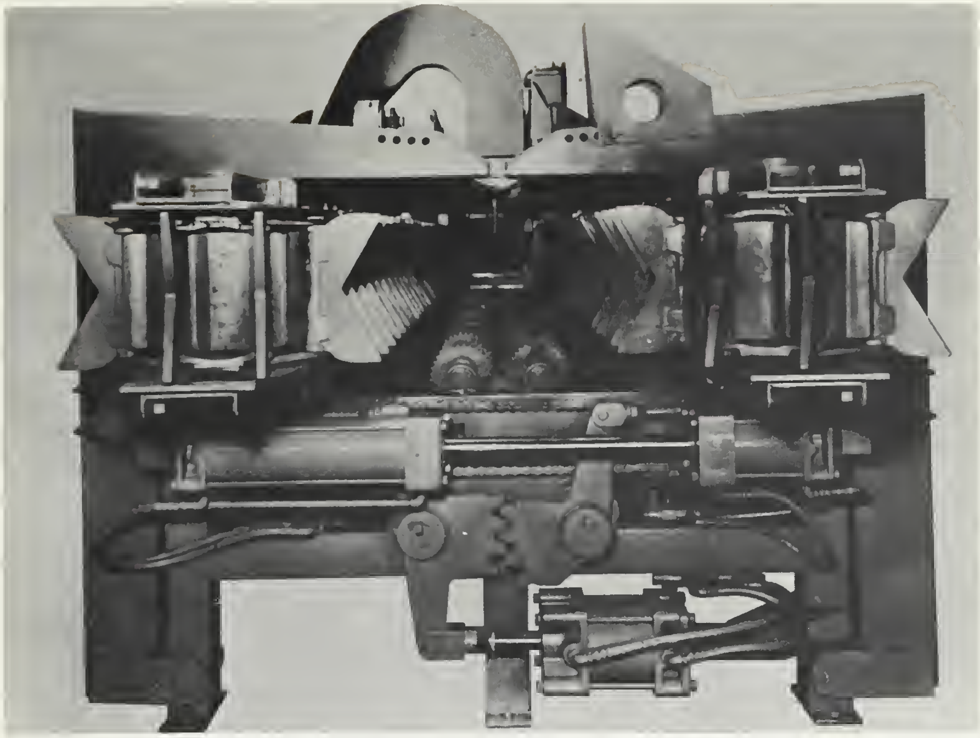


Figure 11.--Stetson-Ross No. 4 Beaver with self-centering feeder, log turner, and "V" loader (Stetson-Ross photo).

Figure 12 illustrates the well-designed installation of a No. 4 Beaver at Northwood Pulp Ltd., Upper Fraser, British Columbia. Logs up to 24 inches in

Figure 12.--Logs, poised for instant delivery, may be fed from either side to the infeed chain of this Stetson-Ross No. 4 Beaver. Production is over 100,000 board feet of lumber per 8-hour shift. The 4-head machine is equipped with segmented heads and hydraulic setworks (Stetson-Ross photo).

diameter are processed. Resultant cants proceed to a twin linebar resaw with merry-go-round arrangement. Wany edges of lumber are removed on a side-chipping edger. Production through the Beaver is in excess of 100,000 board feet per 8-hour shift.

The first Beavers were followed (in straight line) by horizontal circular gangsaws (fig. 13) to resaw the S4S cants into dimension lumber. Some later installations employ single, dual, or even quad bandsaws for resawing. It should be strongly emphasized that the initial canting operation can be done in any way desired, as can subsequent resawing. Flexibility of the system is limited only by the imagination of the mill designer.

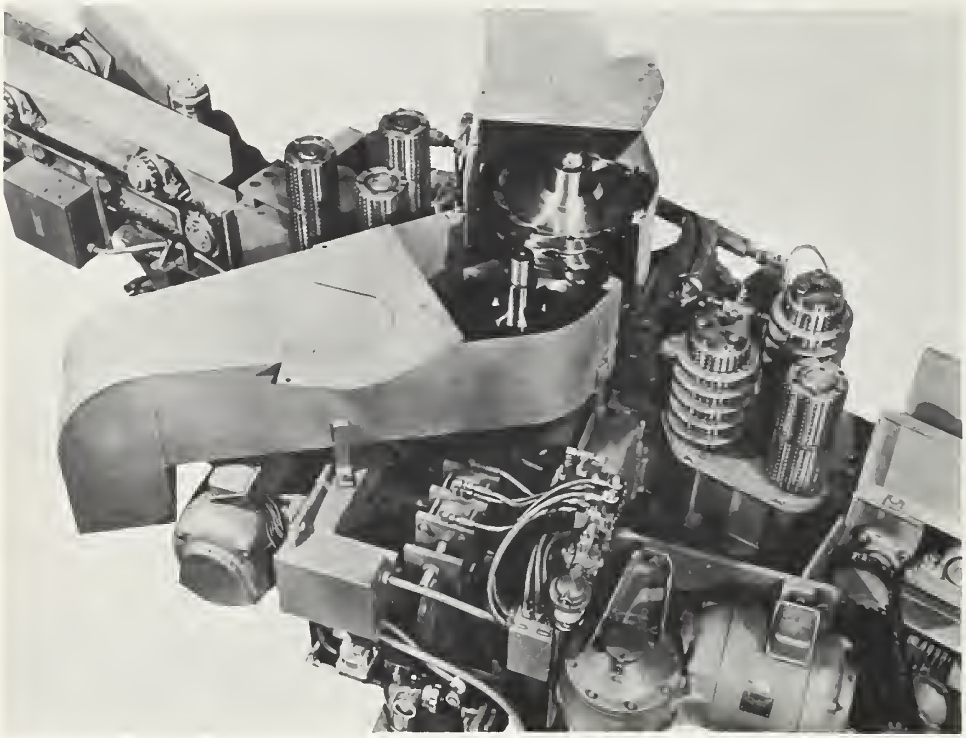


Figure 13.--Stetson-Ross in-line gang resaw designed to reduce cants to dimension lumber. Outfeed is on the right. Each 3,600 r.p.m. mandrel carries 3 to 8 saws and 40 to 100 horsepower. Feed speed of 183 f.p.m. is usual (Stetson-Ross photo).

In addition to the larger machines, Stetson-Ross manufactures a similar but much smaller chipping headrig designed to convert cordwood (up to 11-inch diameter) into hexagonal fence posts (fig. 14). This machine also feeds at 183 f.p.m.

The Chipmunk edger shown in figure 15 is another significant application of a chipping head in the planing configuration. The guide shifts in relation to the fixed head. Splitter saws are available in a modular section following the chipper heads. Available machine sizes are 2 by 24 and 4 by 24 inches.

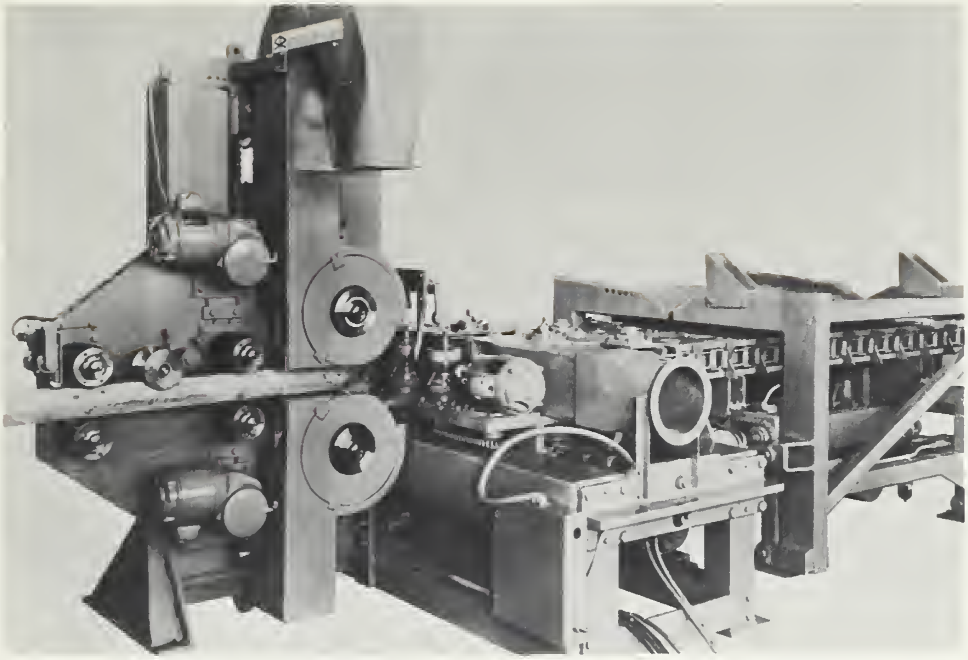


Figure 14.--Small Beaver equipped with heads to produce hexagonal fence posts from cordwood (Stetson-Ross photo).

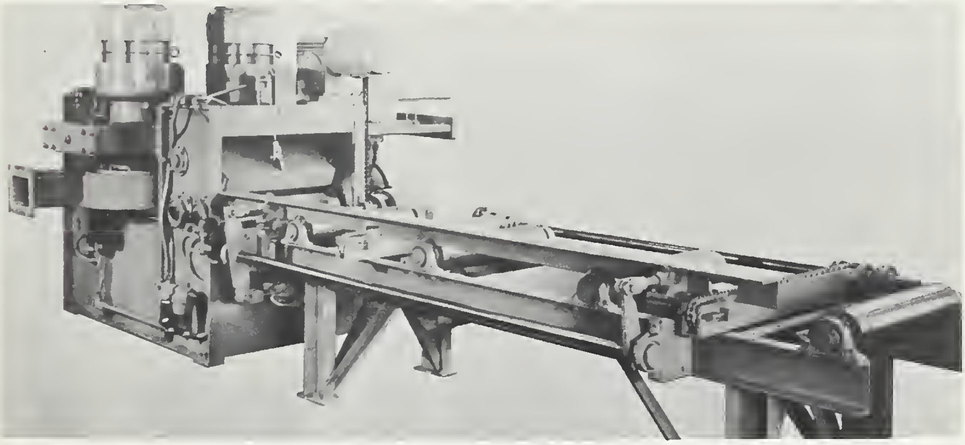


Figure 15.--Two-head Chipmunk side chipping edger. One head is fixed; the other is hydraulically actuated (Stetson-Ross photo).

The bibliography of this paper contains abstracts of a number of trade-journal articles describing Beaver operations (PULPWOOD PRODUCTION, February 1965; BRITISH COLUMBIA LUMBERMAN, February 1966; FOREST INDUSTRIES, March 1966; and FOREST INDUSTRIES, April 1966). A list of installations will be found in Appendix I, page 20.

Canadian Car Chip-N-Saw

The Chip-N-Saw (fig. 16) is a 4-head peripheral milling (fig. 8C) machine. The bottom platen serves as a reference for infeeding logs. Top and bottom cutterheads profile each log--much as a moulder shapes a pattern--in a stepped pattern for subsequent resawing (fig. 17).

Figure 16.--Canadian Car 4-head Chip-N-Saw with built-in circular gang resaw. Feedworks self-centers log laterally and uses bottom platen as vertical reference. Machine particularly designed to profile each log prior to resawing (Canadian Car photo).

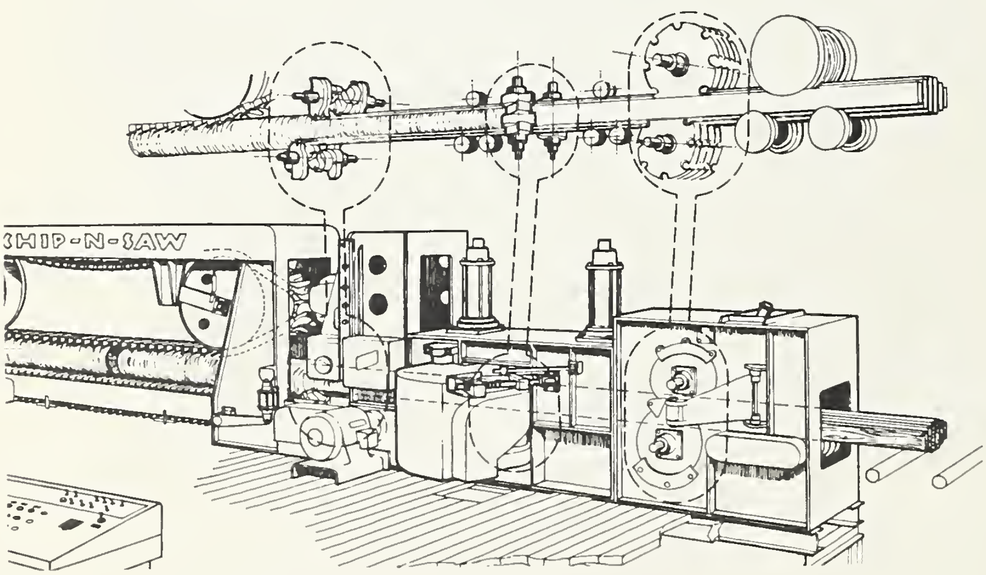


Figure 17.--Cutaway sketch of Chip-N-Saw profiling a log in the same way that mouldings are machined. Usual feed speed is 90 f.p.m. to produce 3/4-inch chips. Motors total 553 hp. as follows: Drive, 28 hp. total; bottom chipping head, 50 hp.; top chipping head, 125 hp.; each of two side heads, 50 hp.; top saw arbor (carrying five $22\frac{1}{2}$-inch, $\frac{1}{4}$-inch-kerf saws), 125 hp.; bottom saw arbor (carrying five 19-inch saws), 125 hp. (Canadian Car sketch).

The firm has recently decided that a tipped cutterhead--intermediate between the 90-0 situation (figs. 7, 8C) and the 0-90 situation (figs. 7, 8A)--is the best arrangement. The 2-head chipping edger followed by a circular ripsaw (fig. 18) reflects this idea.

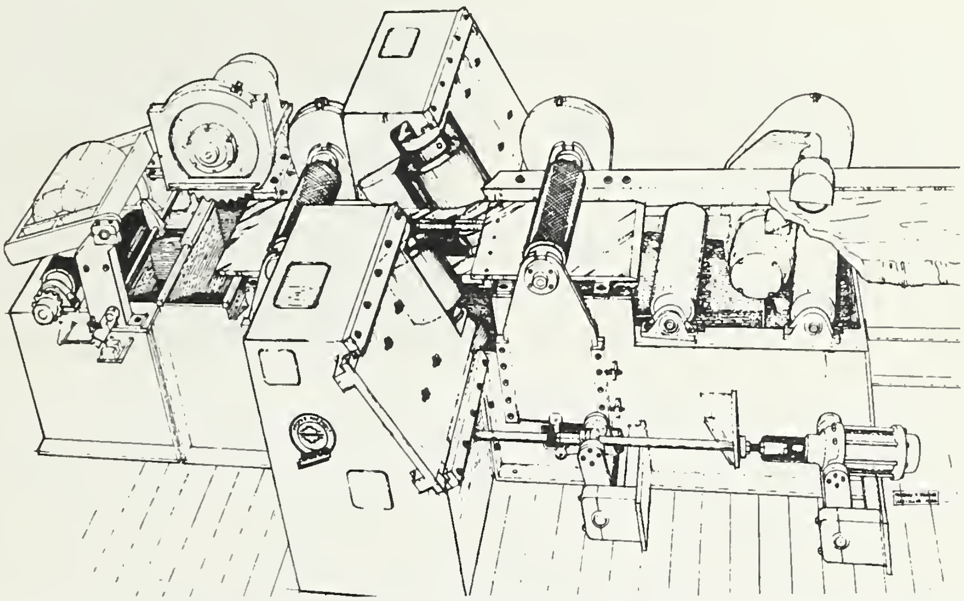


Figure 18.--Two-head edger-chipper followed by a circular ripsaw (Canadian Car sketch).

An idea of the productiveness of the equipment is gained from abstracts of plant descriptions (SOUTHERN LUMBERMAN, April 1966; and FOREST INDUSTRIES, November 1966) included in the trade-journal bibliography. Machine installations are listed in Appendix II, page 21.

Soderhamn "H-P Canter"

In 1965 Soderhamn of Sweden applied one of its chipper designs to a 2-side canter. This 2-head machine, which is a much-modified sawless version of the end-milling configuration (fig. 8B), was given considerable publicity and then withdrawn from the market during 1965, presumably because no satisfactory feedworks had been developed. An abstract of an article (NORTHERN LOGGER, 1965) describing the equipment is included in the trade-journal bibliography. In 1967 Soderhamn designed a tong-type gripping mechanism to feed each incoming log in a straight line through the canter. In May of 1967 the manufacturer reported that two machines were operating in Finland but that none had yet been sold on the North American continent.

J. A. Vance Chip-O-Matic Canter

The Chip-O-Matic, a 2-head end-milling machine using a modified version of the configuration shown in figure 8B, was developed by J. L. Wall, a millwright at the Thompson Lumber Company of Ailey, Georgia. A prototype has been in operation at the mill since December 1965. Manufacturing rights have been acquired by the J. A. Vance Company, a division of the Union Tool Corporation.

A top view of the model displayed at the 1967 machinery show of the Southern Pine Association illustrates the arrangement of the two opposed end-milling discs, each of which carries four scoring knives and four chip-severing knives (fig. 19).

Figure 19.--View from outfeed side of Vance Chip-O-Matic canter showing one of the two opposed end-milling cutterheads. Four scoring and four chip-severing knives are mounted on each 100-horsepower head.

Figure 20 shows the first machine manufactured by J. A. Vance. It was installed in 1967 at the Del-Cook Lumber Company in Adel, Georgia. An abstract of an article (PULPWOOD PRODUCTION, 1967) describing the installation is included in the bibliography.

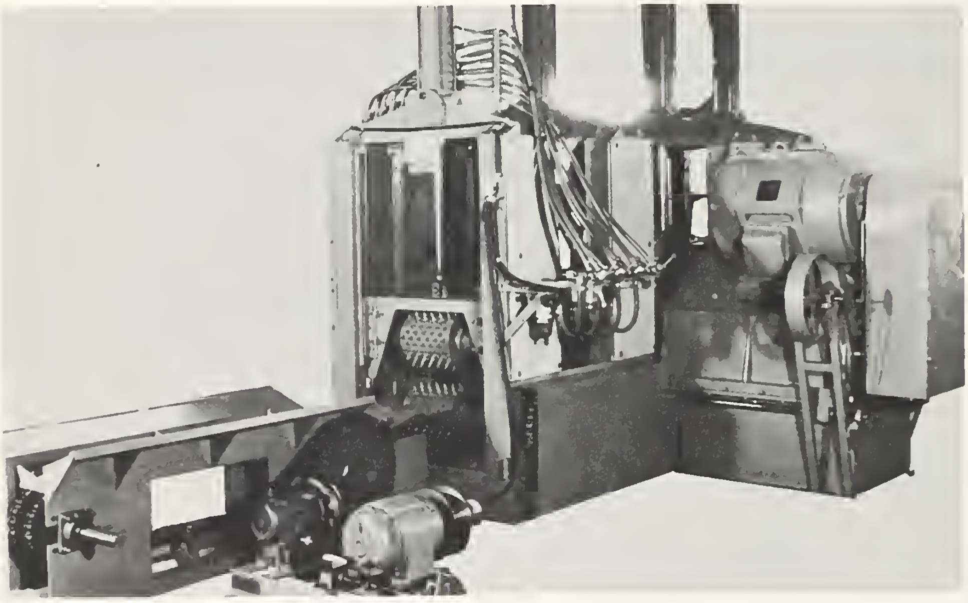


Figure 20.--Infeed end of Chip-O-Matic canter (J. A. Vance photo).

A FORECAST

From the appendices and the previous discussion it can be observed that more than 40 machines have been installed in the short space of approximately 4 years. I am informed by the manufacturers that sales are accelerating. Lumbermen throughout North America and the world are closely following the development of these chipping headrigs. The chipping headrig (and edger) is likely to become the most important innovation in mechanical conversion since the invention of the mechanical ring barker.

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________ 1955. An analysis of the lumber planing process: Part I. Forest Prod. J. 5: 255-264.

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Dobie, J., and McBride, C. F.
1964. Lumber and pulp chips from small logs. Brit. Columbia Lumberman 48(9): 60, 62, 64.

The Chip-N-Saw, with a series of chipper heads operating on the peripheral milling principle, profiles debarked logs in 2-inch steps. The cants are then converted to lumber by an in-line sawmill. Stated capacity is 80,000 board feet of lumber per 8-hour shift on logs 12 inches in diameter and less (averaging 9 inches). The average study log had a 9.7-inch top diameter, was 14.7 feet long, and yielded 64 board feet of 4/4 and 8/4 lumber (7.9 board feet of lumber per cubic foot of log). Overrun (B.C. log rule) was 56 percent. Sawdust averaged 7 percent of log volume, 1/3 to 1/2 of that from a conventional sawmill. Chip yield per 1,000 board feet of lumber recovered was equivalent to 40 cubic feet of solid wood, or about 1,000 pounds ovendry. Relative lumber recovery was higher from short than from long logs.

Anonymous.
1965. Small logs processed efficiently by Selectric "Beaver" system. Pulpwood Prod. 13(2): 12.

Analysis of advantages in Beaver peripheral-milling headrig for random-length logs. Elimination of $\frac{1}{4}$-inch kerf on each cant face increased chip recovery by 2,000 cubic feet of solid wood per 8-hour shift, assuming 6-inch cant faces and average sustained feed speed of 100 f.p.m. (maximum lineal feed speed is 183 f.p.m.). At a chip price of $6 per ton, the additional revenue from kerfless conversion, as compared to conventional sawing, is $360 per 8-hour shift. Seven-inch logs 8 feet long have a Scribner scale of 10 board feet. Average recovery from such logs was 16 board feet, that is, 60-percent overrun. Data based on 8 months of experience with No. 2 Beaver by Del Connor Lumber Company, Inc., Darby, Montana.

Wretne, Arne.
1965. Trends in chipping at the sawmill. Northern Logger 14(3): 13, 15.

In the H-P Canter 66 knives are mounted in spirals on each of two cutterheads. Each cutterhead has the shape of a hollow and relatively flat truncated cone. Each knife cuts on two edges. Fibers are severed and wood is removed in a modified end-milling configuration to form pulp chips. No sawdust or slabs are generated. Random-length logs up to 26 inches in diameter can be slabbed (two sides) to 18 inches in one pass. If desired, the cutterheads can be brought together and the entire log chipped. The machine requires 150 hp., feeds at 160 lineal f.p.m., and requires no heavy foundation. A nomogram relating log diameter, feed rate, and cords per hour is included. Feedworks for centering log not illustrated.

Anonymous.

1966. Less than 3% waste in whole log processing. Brit. Columbia Lumberman 50(2): 52-54.

A small mill for maximum recovery of lumber and chips from small logs has been set up by B.C. Interior Sawmills, Ltd. Waste from the new mill amounts to less than 3 percent (scragging gives 30 percent waste). Up to 49,000 board feet from 2,200 logs have been processed on a single shift with three men on the main floor. Production should average 45,000 board feet per shift. Barking and sorting operations are combined with those of the older conventional sawmill, which handles prime sawlogs for dimension.

The small logs (averaging 7-inch top and 20 feet in length) go to a cross-transfer storage deck for the Beaver canter-chipper. One man controls barker, log deck, and Beaver. The Beaver Selectric takes a $3\frac{1}{2}$-inch top to 11-inch butt.

Heads driven by 60 hp. motors chip four sides of each cant in one pass at 183 f.p.m. A linebar resaw with six push-button sets from 7/8 to 4 inches and infinite settings from 4 to 9 inches allows maximum grade recovery from each cant. Variable-speed feed rollers (300 f.p.m. for 4-inch cants, 150 f.p.m. for 9-inch) are individually powered by hydraulic motors. The operator controls outfeed gates to direct material to the edger-chipper or return it to the resaw via a merry-go-round. A Chipmunk edger-chipper with no saws feeds up to 4-inch thickness and 9-inch width at 350 f.p.m. A 60 hp. motor powers each head. Two trim saws to cut odd lengths are 24 feet apart, with 2- and 4-foot trim stops. Lumber is 80-percent lodgepole, normally 20 feet or shorter (maximum 24 feet) with primary sizes 2 by 3, 2 by 4, and 2 by 5 inches for the U.K. market. Grades so far have run 88 percent construction, 10 percent standard, and 2 percent utility. In lodgepole pine small knots are tight, permitting a high yield of standard and better grades; few, if any, clears are recovered. Costs are higher for small logs than for the prime logs cut in the conventional mill. Return on lumber also is less, but good chips and some cards are yielded. The conventional mill, which cuts 22 million f.b.m. yearly, produced 0.5 units per M f.b.m. compared with 1.3 units per M f.b.m. from the new small-log mill. The total is 100 units daily.2/

A steel trough conveyor with cast iron chain, 15-unit chip bunker, diesel Scoopmobile LD-7A, self-opening 26-inch barker (feed of 140 f.p.m.), and 5-arm unloader are used. Total connected horsepower is 650, with primary power available on the site. Cost of $375,000 for the small-log mill includes a post-and-beam building with floor dimensions of 50 by 120 feet, equipment, and electrical installations. Plant layout shown.

2/ A unit is 200 cubic feet of chips. A unit of Douglas-fir chips weighs approximately 3,300 pounds green and 2,050 pounds ovendry; a unit of western hemlock chips weighs approximately 3,900 pounds green and 1,850 to 1,950 pounds ovendry; no figures at hand for lodgepole pine.

Anonymous.
1966. Small logs receive primary breakdown in chip-cant mill. Forest Ind. 93(3): 104-105.

E. Manke & Sons on Hylebos Waterway, Tacoma, Washington, utilizes logs 5 to 24 inches in diameter and up to 24 feet long to produce cants and chips for remanufacture elsewhere. After being bucked with a circular deck saw, the logs pass through a Nicholson barker and Stetson-Ross No. 4 Beaver chipper-canter. The infeed table adjusts automatically for sweep and flare. Cants are produced at a rate of 183 lineal f.p.m.; chips have a uniform fiber length of 5/8-inch. From the roll case, random-length cants move via transfer chains to be steel-strapped into 3,000-board-foot bundles for shipment.

Anonymous.
1966. Stud mill installation expands timber supply. Forest Ind. 93(4): 94-95.

The Del Connor Lumber Company at Darby, Montana, has installed a small-log stud mill (in addition to its 50 M per shift, 7-foot band headrig) to utilize nearby stands of suppressed timber (Douglas-fir, lodgepole pine, spruce, and white fir). A Selectric Beaver No. 2 chipper-canter was installed along with a Selectric dimension machine to convert cants into 2 by 4's. The dimension machine carries carbide saws that take a 5/32-inch kerf. Production on the Beaver averaged 25 M b.f. per shift initially (maximum 33 M b.f.); addition of a separate infeed for peeler cores raised this to 45 to 50 M b.f. per shift. The average log fed to the Beaver is $6\frac{1}{2}$ inches in diameter and contains 30 board feet. After modifications, maximum log size will be 12 inches, with cants up to 8 inches possible. Two studs are recovered from each $5\frac{1}{4}$-inch core. Production runs 60 percent cores and 40 percent logs. Lumber is air-dried and surfaced in a planing mill. Logs 8 to 20 feet in length are fed by a LeTourneau stacker to a stationary deck, where a Prentice Hydraulics, Inc., grapple loader is mounted. Here logs are sorted and placed on the end-haul chain to a Morbark 24-inch barker. Three operators (one each for loader, barker, and chipper-canter) and two greenchain pullers (four when handling cores) are required.

The stud mill (sawing lodgepole pine) yields 1.2 units of chips per M b.f. (cores yield only about 0.4 unit) compared to between 0.6 and 0.7 unit from the bandmill (utilizing Douglas-fir). Chip yield from both band and stud mills totals 80 units per day. The installation includes a Rotex 122 screen with capacity of 21 units per hour, a CM&E Norman Model 48 chipper for overs and sawmill waste, and a 14-unit-per-hour Rotex 82 screen.

Anonymous.
1966. "Chip-N-Saw" featured in new Virginia operation. Southern Lumberman 212(2640): 31-32.

The Chip-N-Saw is used in a new 16-man, half-million-dollar sawmill to produce lumber from timber normally considered pulpwood, i.e., 5 inches and up. Spain Lumber, Inc., at Wakefield, Virginia, expects an initial daily output of 40 to 50 M b.f., with 60 to 75 M predicted by the

end of 1966. One man at a console operates the 24-ton machine, producing lumber and chips in one operation. It has a capacity of five 16-foot logs a minute, yielding up to 6,240 board feet per hour in sizes ranging from 1 by 4 to 2 by 10. Southern pine is the major species utilized, but results in hardwood have also been excellent. Other equipment includes: Cambio debarker, Irvington V-Line end trimmer, Standard dry kiln, Moseley lumber sorter, Prentice hydraulic loader, Yates-American A-20 motorized head planer, Yates-American V-160 linebar resaw, Fairbanks-Morse scales, lumber haul-up, breakdown hoist, strip separator, and Convoy treating vat.

Anonymous.
1966. Sawmill increases lumber, chip output. Forest Ind. 93(12): 118-119.

An increase of 35 percent in lumber production by Balco Forest Products, Ltd., at Heffley Creek, British Columbia, was realized with installation in March 1966 of a whole-log processing machine in an existing sawmill. The Model 1242 Chip-N-Saw, operated by one man, produces pulp chips and dimension lumber from logs with top diameters of $4\frac{1}{2}$ to 14 inches. Most material is 7- to 11-inch lodgepole pine. On the average, 1,400 logs per shift are processed, but 2,000 have been handled. With 30 pieces per M b.f. lumber scale, 45 to 50 M b.f. are produced per shift. Chip recovery is 1.2 units per M b.f. Lumber size may be adjusted from 2 by 3 through 2 by 12. Slab material is chipped away to profile a stepped cant ahead of double-arbor saws. Most logs are bucked to 16 feet. Short and long logs have separate infeed chains. Debarking is by a Nicholson 36-inch ring barker with a Morbark rosserhead barker for large logs. An end-haul chain carries the logs to a system of storage and feed chains serving both the Chip-N-Saw and a circular headrig with cant gang and edger. Production from both systems merges ahead of a rough trimmer. Grade recovery is not as high as from selective sawing, but this loss is more than offset by savings in production costs.

Anonymous.
1967. The Vance Chip-O-Matic Canter. Pulpwood Prod. 15(4): 22, 24.

The prototype Chip-O-Matic canter designed by J. L. Wall was installed at the Thompson Lumber Company of Ailey, Georgia. The machine has been further developed by the J. A. Vance Company of Winston-Salem, North Carolina, who manufactured and installed a second model at the Del-Cook Lumber Company in Adel, Georgia, in January 1967. The Chip-O-Matic carries two end-milling, six-knife cutterheads, each driven by a 100-hp. motor. Distance between cutterheads is adjusted for each log by a setworks. The machine will accept logs 4 to 28 inches in diameter. Two sets of spiked hold-down rolls in front of the cutterheads, and two sets behind, are controlled by the single operator to guide random-length logs. Minimum log length is 8 feet. Twisting of logs is reportedly minimized by 3/4-inch teeth on the feed rolls and by intermediate spur rolls. The basic machine weighs about 15,000 pounds, sells for $25,000, and occupies a floor space 11 feet 5 inches long and 10 feet 9 inches wide. It stands 6 feet 4 inches high. At a log feed rate of 100 lineal f.p.m., the canter produces half-inch chips. Feed speed may be varied.

At the Del-Cook mill, long logs are first debarked and then bucked. Large logs are diverted to a conventional headrig; the Chip-O-Matic receives those that will yield cants 8 inches thick or less, as this is the maximum capacity of the double-arbor edger behind the machine. No production figures are given.

APPENDIX I

BEAVER INSTALLATIONS AS OF APRIL 14, 1967

1. Del Connor Lumber Company, Darby, Montana, No. 2 Beaver, dimension machine.1/
2. Anaconda Company, Bonner, Montana, No. 2 Beaver with side chipping edger.1/
3. Diehl Lumber Company, Plains, Montana, No. 4 Beaver, dimension machine, side chipping edger.1/
4. Paul O'Leary Lumber Company, Meridian, Mississippi, No. 2 Beaver, dimension machine.1/
5. B.C. Interior Sawmills, Kamloops, British Columbia, No. 2 Beaver, side chipping edger.1/
6. Union Camp Corporation, Franklin, Virginia, No. 2 Beaver.1/
7. Manke & Sons, Tacoma, Washington, No. 4 Beaver.1/
8. Dierks Forests, Inc., De Queen, Arkansas, Hex Post Beaver.
9. Dierks Forests, Inc., Mountain Pine, Arkansas, No. 2 Beaver, side chipping edger, dimension machine.
10. Flack-Jones Lumber Company, Summerville, South Carolina, No. 4 Beaver.
11. Northwood Pulp Ltd., Prince George, British Columbia, No. 4 Beaver, side chipping edger.
12. Customer's name withheld. Complete Beaver sawmill for Europe, including No. 4 Beaver, side chipping-edger, linebar resaw, and all conveying and handling equipment.
13. J. P. Lewis Company, Beaver Falls, New York, No. 4 Beaver.
14. Herman Wilson Lumber Company, Leola, Arkansas, side chipping-edger.
15. Anderson Corporation, Mollalla, Oregon, No. 4 Beaver.
16. Anaconda Forest Products, Bonner, Montana, No. 4 Beaver.
17. Vanport Products, Inc., Boring, Oregon, No. 4 Beaver.

1/ Manufactured by Mill Equipment, Inc., prior to Stetson-Ross's acquisition of manufacturing rights.

APPENDIX II

CHIP-N-SAW INSTALLATIONS AS OF MARCH 1, 1967

1. John Ernst Lumber Company, Quesnel, British Columbia.
2. S. M. Simpson, Ltd., Kelowna, British Columbia.
3. Plum Creek Lumber Company, Columbia Falls, Montana.
4. Spain Lumber, Inc., Waverly, Virginia.
5. Chief Joseph Lumber Company, Joseph, Oregon.
6. St. Maries Plywood, St. Maries, Idaho.
7. Balco Forest Products, Kamloops, British Columbia.
8. Cascade Locks Lumber Company, Cascade Locks, Oregon.
9. Northern Timber Company, Phillipsburg, Montana.
10. Merrill & Ring Western, Port Angeles, Washington.
11. Temple Industries, Pineland, Texas.
12. Lelco, Inc., Bend, Oregon.
13. Fort St. John Lumber Company, Ltd., Chetwynd, British Columbia.
14. Simpson Timber Company, Ltd., Hudson Bay, Saskatchewan.
15. B. C. Forest Products, Ltd., Morfee Lake, British Columbia.
16. Crown Zellerbach Company, Ltd., New Westminster, British Columbia.
17. Canyon Creek Sawmills, Ltd., Valemount, British Columbia.
18. Rocky Mountain Timber Company, Inc., Columbia Falls, Montana.
19. Weyerhaeuser Company, Klamath Falls, Oregon.
20. Clearwater Timber Products, Ltd., Clearwater, British Columbia.
21. Kaibab-Crofts Industries, Panguitch, Carfield County, Utah.